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INFLUENCE OF SILICA STONES ON THE STRENGTH OF GLASS CONTAINERS

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The presence of a stone or stones in a glass container, in addition to presenting an unsightly appearance, may decrease the strength of the container and render it unfit for use. Such containers usually are discarded at the lehr by the selector. In practice, stoney ware is sometimes packed; accidentally, in those cases where the selector has missed the imperfection and intentionally, in those cases where the ware being made does not need to be pressure or thermal shock resistant. The latter case is especially true if the stones are small in size and number.

So far as is known, the effect of stones on the decrease in strength of glass containers has not been systematically investigated or reported in the literature. Insley[1] in a paper which expressed the need for more information on the relationship between various types of stones and various forms of breakage stated that "Cristobalite, tridymite and quartz have higher rates of contraction than does the surrounding glass, and therefore the strained area surrounding such stones should be in tensile radial stresses. As corundum and mullite have expansitivities lower than that of the glass, compressive stresses are developed." This "type of stress—type of stone" relationship plus the difficulty of obtaining samples having stones of the same size, shape and position readily explains why a systematic study of this subject is difficult. In some cases, however, general information may be obtained. The present report is of this nature and represents the results obtained on an investigation of a "customer breakage" complaint.

Excessive breakage was being experienced on a 12 oz. round packer container and the field inspector reported that the breakage was due to the presence of stones in the glass. In addition, it was also stated that the "black stones" would break if given an impact while the "white stones" would not. Typical fractured samples showed that the broken bottles were all cracked through a stone and that all of the breakage was confined to those bottles having stones near the inside surface (these are the inspectors "black stones"; in colored glass, stones on the interior surface appear black in color). The stones in the bottles ranged in size from 1 mm to 4 mm in diameter, and the petrographic examination indicated that the stones were silica and were composed of a mixture of large tridymite and small cristobalite crystals, the probable source being either old scum or crown drippings.

The bottles on hand were reselected and those containing stones were used for the laboratory tests. Visual examination of these samples indicated that the position of the stones in the glass could be roughly classified into three general locations. (Figure 1.) Type A was located on the outside surface of the container and predominated in number; Type B was located in the interior of the container wall and were fewer in number, while Type C was located on the inside surface of the container and were least in number. Only those containers having Types A and C stone locations were used in the tests.

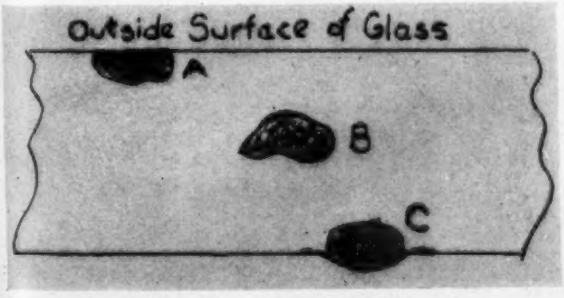

Fig. 1. Diagramatic representation of location of silica stones.

Fig. 2 (right). Stone corresponding to Type C (showing the extrusion of the stone glass area beyond the normal inside glass surface).

Resistance to Impact

The resistance to impact was measured by revolving the bottle around its axis while lightly tapping its out-

Fig. 3. Microphotograph of stone in polarized light. Bright areas show the strain pattern caused by the stone.

Fig. 4. Microphotograph of stone showing original crack (x), (Ordinary light, original section.)

side surface with the ball end of a glass cutter. These impacts were applied around the circumference of the bottle in such a manner so as to include the stone and the area directly around the stone. One hundred bottles containing Type A stones and one hundred bottles containing Type C stones were tested by this procedure. The entire lot of Type C samples broke in the test, the fractures originating either in the stone itself or in the area immediately surrounding the stone (Fig. V). No breakage was obtained with the Type A stones; in fact, these stones could be repeatedly tapped without the formation of a crack, the only result being that the stone was powdered out from the glass.

Microscopic examination of the type C stones was then made. Looking down at the stone through the inside edge it was observed that the stone-glass area extruded beyond the normal inside surface and that only a thin layer of glass preventing the stone from being exposed. (Fig. II) When viewed normally and with polarized light, the type C stones were found to be surrounded by an area of intense strain, the resulting strain pattern depending upon the size and shape of stone. (Fig. III) With ordinary light the stone itself seems to be internally cracked and in some cases (Fig. IV) these cracks extended out into the adjacent strained area. The weakness on impact of this type of stone therefore seems to be very similar to the internal scratching phenomena. Such stones, located very close to the outside surface of the inner wall and being both internally cracked and surrounded by an area of high stress, require only a small amount of additonal energy for the original crack to develop into a large fracture.

Fig. 5. Microphotograph of impact fractures of Type C stone.

Thermal Shock Resistance

Using a manually operated thermal shock apparatus with a 15 sec. transfer and a cold water temperature of 70°F, a progressive thermal shock test was run on bottles having Type A stones, Type C stones, and on bottles having no visible stones. A sample size of 50 was used and the bottles were selected so as to include about an equal amount of samples having the two types of stones located in (1) the base, (2) Murgatroyds' belt, (3) the center of the barrel, and (4) the shoulder of the bottle. After each test the broken bottles were carefully examined and the origin of the fracture located and the path of the fracture traced. The breakage results are given in Table I and show no apparent difference in the strength of the three groups of bottles. In all cases the origin of the fracture was in the baffle mark of the bottle, the breakage being typical thermal shock breakage. In no case did a fracture originate in a stone nor did any of the secondary fractures originate or go through a stone. The only conclusion that can be drawn from these test results is that the thermal shock method tested only the weakest part of the bottle (in respect to thermal shock resistance) and that the stone area regardless of its position in the bottle was still much stronger than the weakest part of the bottle.

Table I

Temp. Diff.	No. Bottles Broken		
T°F	Type A	Type C	No Stones
80	0	0	0
90	0	0	0
100	2	2	3
110	14	10	12
120	12	14	14

(*Continued on page* 478)

LAW AND CUSTOM

By FRANK W. PRESTON

Editor's Note. The opinions expressed in this article are those of the author and not necessarily that of any of the parties to the suit nor of this publication. Because of the delay in publication, Dr. Preston wishes it to be made clear that his paper was prepared immediately after the preliminary decision was promulgated and without consulting any of the parties concerned. *The Findings of Fact and Conclusions of Law*, and the *Final Decree*, have appeared since the paper was written.

The Toledo Court has handed down its decision in the suit brought by Thurman Arnold against a large part of the glass container industry. It is not likely that the industry will concur in the opinions of the court; it is possible that some or all of the defendants may take an appeal to higher courts; it is possible that the court's verdict may be reversed or modified. But it will be well for the industry to take cognizance of its situation since the verdict may stand for ten or twenty years; and of the possibility that the Department of Justice, having tasted blood, may institute still further proceedings.

We do not here propose to discuss the matter from a legal angle. The court did that, in some one hundred and seventy pages of print. The court cannot discuss it from any other angle. We are concerned with the broader problem; the social and sociological aspects, and with the industrial and technological problems. For though the defendants must be judged by the law, the law in its turn may be, and must be, judged by the citizens who are under the law; and their verdict will be rendered according to common sense, according to the social and sociological effects of the law. All laws are not necessarily good laws: they are often passed by not-too-wise legislators, or not too unselfish legislators; construed by courts in a narrow legalistic fashion; sometimes written into the Constitution. Sometimes the constitution has to be re-amended; sometimes the courts are reversed by higher courts; and sometimes the Supreme Court reverses itself, or, in effect is reversed by the common-sense judgment of the people.

The Court's opinion is largely based on the writings of Herbert Knox Smith, who has long been dead. This prevents his testifying in court in his own defense; he is in no position to interpret his own writings. Against them, the Court inveighs in unmeasured terms, and wants to know why a criminal charge was not brought against him. The Department of Justice, he suggests, was remiss in not doing so. It is we believe, not customary to bring lawsuits against alleged criminals long since dead, though in "The Hunting of the Snark," the sequel to *Alice in Wonderland*, a pig was once tried under those circumstances, and sentenced to transportation for life. That might be the proper sentence for Herbert Knox Smith, if he were in fact equally guilty; but the verdict actually pronounced does not fall on Herbert Smith, but on a whole industry.

In arraigning Herbert Smith, and quoting at length from his writings, the Court does not keep those writings in chronological order, to show the development of the man's ideas. It quotes mainly from Smith's writings of 1930, and then introduces a document of 1925, against which the fulminations are principally directed. From this, it might seem that the Herbert Smith of 1930 was, in the Court's eyes, a much less criminal person than the Herbert Smith of 1925.

Smith died in 1931, and we don't know how his thoughts would have developed under the New Deal. But it is worth while to recall the background of his last writings, many of them quoted in the Court's opinion.

The year 1930 was the year of the Smoot-Hawley Tariff Act. This was the culmination and high-water mark of a decade or more of legislation designed to eliminate competition from the American scene. It was an Act passed by Congress, the representatives of the American people. Though condemned by the present writer (Glass Industry, Vol. 11, p. 162, 1930), and many others, it undoubtedly had a majority of the American people behind it. They did not approve of competition, and so far as the foreign angle was concerned, they intended to suppress it if they could. It is held by many that the Act was the signal for the rise of Hitler, and, if so, it was a far worse act than any thought or act of Herbert Smith. Insofar as Herbert Smith's writings of 1930 indicate any hope of reducing the incidence of competition, they are in line with the public sentiment of the time; and nothing in his private writings can compare in viciousness with some of the public acts of the U. S. Congress of that year.

Herbert Smith passed away, and there passed away too the incompetent Congresses with which he was contemporary. The present Department of Justice and its crusaders belong to the era that began in 1933. This Administration, through the State Department, set about to restore, by reciprocal agreements, some of the overseas trade that the previous Congresses had destroyed. But competition in the American market was still taboo. It was the present Administration, through its Department of Agriculture, that ploughed up the cotton crops, slaughtered the baby pigs, and restricted the potato crop. A free market was the last thing the Administration desired: competition, forcing down prices for farm products, so far from being a boon to the nation, was anathema, a subversive influence. The government therefore took steps to restrict competition. Clearly, therefore, in the eyes of both Republican and New Deal governments, there is nothing sacred about competition, nothing inviolable about a free market. It is in this milieu that Herbert Knox Smith lived, and in it he died.

Now the essence of Anglo-Saxon law is that the law is a statement of the customs of the people. Not all customs need to be raised to the rank of law, carrying with them legal "sanctions" or punishments for violation; but all laws must represent customs and accord with customs. If the "law," ignoring this point, is con-

trary to custom, it is merely an *enactment*, not a true *law*. It can only be enforced by violence, and intermittently. Perhaps it becomes a "dead letter" at once; perhaps it has to be repealed. Laws contrary to custom flout the fundamental principle that government must rest on the consent of the governed. The custom itself may be foolish or even evil, but it cannot be corrected by mere force, by passing an act contrary to general opinion.

A thousand years or more ago, our Anglo-Saxon ancestors tried the accused by enquiring what was the custom of the country. If his alleged crime were an unusual one, it might be necessary to call together the Council of the Elders (Witangemot) to search their recollections for similar cases in times past. This is still the basis of our law; we do not decide whether a man is a criminal simply by reference to an enactment, or even to the "plain intent" of the legislators. We should decide our cases by precedents. The law is not made by the legislators. The law is not made until it is adjudicated, until it is fitted into the general corpus of law, into its proper place among the customs of the country.

Now it is clear that Herbert Knox Smith, in the passages most severely denounced by the Court, was ruminating on this very point. He asks himself, or his reader, frankly, "What is the law?" He says specifically that the law is vague. It seems reasonable to suppose that he believed that. Otherwise, much of what he wrote is entirely beside the point. Not "a conviction of guilt" but uncertainty of the law's intent is in his mind. And studying the enactments and meditating on the interpretation that may be given to them under the customs, Smith reached the conclusion that he was acting legally, but that some crusading government officer might decide to challenge the legality. Then, in view of the uncertainties of the law, anything might happen.

Many criminals were made by the Prohibition Act and the Eighteenth Amendment. The law itself was fundamentally at fault. It was at variance with custom; it flouted the Common Law. It was a product of crusading zeal, not of wisdom or balanced judgment. In view of the complete failure of Thurman Arnold to sustain a single one of his contentions before the Court in the Aluminum suit, and the enthusiastic endorsement of his every contention by another Court in the Glass Container suit, it seems very probable indeed that the law *is* highly uncertain: it may even be that the enactments themselves (the Anti-trust Acts) are not in accordance with established customs or social structure.

We desire a free market, or think we do. The government in the Smoot-Hawley and pig-killing acts has tried to restrict the market. The N. R. A. tried to restrict it. Various war time measures also operate to restrict it. The government has proposed combinations of railroads that have much the same effect. The tendency towards a few large companies is as unmistakable as the tendency toward nation states and super-nation states in place of city states and principalities. The Toledo Court's ambition "to restore competition to the industry" does not mean an increase in the number of competitors. It is more likely to reduce the competition to a few competitors. Hartford's crime, if any, is not in eliminating competitors among the glass makers, but in restricting the market for inventions.

We cannot subscribe to the view that the sole justification for industry's existence is its providing of adequate goods at minimum prices. There is some evidence that the Court so conceives it. Industry has other functions, some political, some humanitarian, in this imperfect world.

Politically, a sound industrial system makes for stability at home, and for strength abroad. A poorly industrialized nation has no strength to confront foreign enemies; and at home its people are apt to live in poverty, ill health, and disease. Industry is not automatically a correction of these evils, but it can help often; and for one or the other of these reasons, all countries desire to become industrialized.

From a humanitarian standpoint, industry"s business is to provide "steady" employment as far as possible, not spasmodic employment. In this respect, the glass container industry has an enviable record. Probably no other industry has one as good. The Court says, and the Court is correct, that for the purposes of a lawsuit, this is immaterial. If we keep all the laws but one, and break that one, then we are guilty of all. The good we do is immaterial; we are being judged for the evil of which we are accused. The good can be interred with our bones.

But this is the legal and legalistic aspect. The Court can judge on no other basis. But posterity, and our contemporaries, if they concern themselves with the matter at all, will judge on a different basis. Did Owens, and Corning, and Hartford place America in the forefront of glass technology, or did they leave us dependent on Germany and Japan for our needs? Obviously, if America is in the van of progress in this field, it is not the government or the Bureau of Standards that did it. It was done by the men and companies who now stand condemned. If this be treason, make the most of it.

During the Depression, who stood out like a beacon light? The W. P. A.? The killers of little pigs? Did they restore prosperity? Did they advance technology? Did they offer any worthwhile alternative to Hitler's New Goosestepping Order? Hitler restored employment by equipping an army. The W. P. A. created employment that self-respecting Americans found it hard to accept. The glass container industry for some reason, good judgment, good management, or good fortune, maintained employment throughout the depression. It went further; out of its profits it financed the development of fibreglass, which is rapidly booming an industry comparable with the container industry itself, and vastly useful in the present war effort, though never thought of originally as a war industry.

Probably, America is "conserving" more copper today because of this development than is being conserved by anything the copper industry itself can do. For a 1 H.P. motor will deliver 2 H.P. if the copper wire is insulated with glass fibre instead of cotton. This means in effect that every second motor does not need to be built, and this saves a good deal of copper and of iron and other materials too.

By these things, in the long run, the public must judge the industry.

THE DEVELOPMENT OF LOW MELTING GLASSES ON THE BASIS OF STRUCTURAL CONSIDERATIONS

By NORBERT J. KREIDL[1]* and WOLDEMAR A. WEYL*

PART IV

THE MELTABILITY OF PRACTICAL GLASSES

In the following chapters, the methods used by the historical and contemporary glass makers to melt their glass at lower temperatures will be described. In this description due consideration will be given to our five structural principles† which may lead to the results obtained by the empirical attempts of the past as well as by the systematic research work of the recent years.

(1) Alkali

The earliest fluxes are, without any doubt, the alkalis which have been introduced in the form of plant ashes. As a flux alkali is most efficient but the impaired chemical resistivity of glasses of high alkali content presents a severe limitation. The history of all other fluxes is the story of overcoming this inherent shortcoming of the oldest fluxing method.

Even a sodium silicate glass containing as much as 80% SiO_2 is subject to corrosion in the atmosphere. High alkali content leads to high thermal expansion which has been desirable for ancient pottery glazes but interfered with many requirements of the later ceramic industries.

The fluxing effect of the alkali oxides can easily be traced back to the simultaneous effect of the increase of the oxygen ratio (second structural change) and the loosening effect of the positive ion on the bonds in the network tetrahedra such as the silicon-oxygen bond (fourth structural change).

(2) Soda-Lime-glasses

The serious deficiencies of the pure sodium silicate glasses explain the early development of fluxes which behave in a similar way to the alkalis but impart chemical resistivity. The first and most important result of these ancient endeavors is the three component soda-lime-silicate glass.

The fluxing principle of CaO is the same as that of Na_2O. Again Ca^{++} does not participate in the glass structure proper and the oxide contributes oxygen to the network, which increases its oxygen ratio. The disturbing action of the divalent Ca^{++} ion on the $Si\text{-}O_4$ structure may be considered larger than that of Na^+. On the other hand it exerts a stronger force on the surrounding oxygens than monovalent ions, thus simultaneously introducing a strengthening factor into the system. The range of the ternary soda-lime-silicate glasses is narrow for the following reasons:

(a) An increase of alkali above 20% provides good meltability, but causes poor resistivity.

(b) An increase of calcium above about the same amount provides meltability without impairing resistivity, but the resulting melts are not stable and liable to devitrify.

(c) An excess of silica impairs meltability.

Up to modern times alkali, and lime in this limited ternary composition field, remained the chief fluxing agents. Only very recently glasses have been developed which combine acceptable meltability with extremely low expansion or extreme resistivity due to the absence of alkali, such as Pyrex and fiber glass.

(3) Fluorine Glasses

The influence on the oxygen ratio was not the only principle which our ancestors applied implicitly in order to improve meltability. Their experience in metallurgy taught them the action of calcium fluoride which decreases the viscosity of glasses just as well as that of slags.

The German name of the mineral fluorspar, "Fluss Spath," means "fluxing Spar" and long before it was used in opal glass the glass maker took advantage of its fluxing power.

This introduces a new principle of weakening the glass structure into the history of glass making, namely, the replacement of the divalent oxygen by the monovalent ion of the same size. (Fifth Type of Structural Change.)

Only recently, has it become possible to offer the correct explanation for the fluxing action of fluorspar and to attribute it to the element fluorine. In earlier times, the metallurgists believed that the effect of fluorspar on the viscosity of a slag consists in the introduction of calcium and the simultaneous removal of silicon in the form of silicon tetrafluoride. Both effects would increase the lime silica ratio of the slag and, consequently, its fluidity. Much of this misconception was due to the difficulty of determining the fluorine content in slags, glasses, and enamels analytically. It had been observed that fluorine compounds escape from the melt, but it has remained ungnown, how much fluorine volatilized and how much remained in the melt. We have to remember that not so long ago even the opacifying action of fluorine in glasses and enamels had been erroneously attributed to the formation of SiF_4 bubbles. At present, it is recognized that in slags as well as in glasses the larger part of the fluorine remains in the melt where it substitutes for the corresponding amount of oxygen. If we maintain the base composition, especially the same ratio CaO : SiO_2 and replace only a certain amount of oxides by fluorides, we still find that the fluorine containing melt is more fluid. The amount of Fluorides which can be introduced into a clear glass is limited by their tendency to crystallize. In soda-lime glasses, more than about 4-5% F causes opacification.

In the usual type of commercial glasses fluorides act

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†See Table V, September 1942 issue, page 357.

as a flux not only by providing a weaker bond than oxygen, but also by increasing the ratio: $\frac{\text{oxygen + fluorine.}}{\text{silicon}}$ (Fifth structural change.)

Fluorides, as a rule, will not form glasses, except BeF_2 and its compounds which have been discussed with this fifth type of structural changes.

(4) Lead Glasses

The invention of lead glasses in the 17th century in England added another important flux to the raw materials of the glass melter. Originally promoted for their brilliancy, they proved valuable for reworking purposes. Tubing and rods for lamp work, glass jewelry, and all early incandescent lamp bulbs were originally made from lead glasses. Prior to its application to the English flint glass lead had been a characteristic constituent of pottery glazes. The use of lead ores in producing a low melting glaze can be traced back to the ancient Assyrians and Babylonians. Following the same principle, the vitrifiable colors used for the decoration of glass, were originally based on low melting frits of high lead content.

The introduction of lead oxide in the place of lime widens the field of commercial glasses. While glasses containing 18-20% wt. CaO are liable to devitrify, a mixture of 90% wt. lead oxide and 20% wt. SiO_2 which corresponds to the ratio of the lead orthosilicate (Pb_2SiO_4) gives still rise to undisturbed glass formation.

The structural influence of large amounts of lead was discussed in a previous chapter and correlated to the third type of structural changes, that of larger ions. The chemical resistivity of lead glass is fair, with the exception of the very heavy lead glasses.

Despite the useful properties of lead glasses, such as their brilliance and their workability, they exhibit serious disadvantages. They must be melted under strongly oxidizing conditions, preferably in closed pots; without these precautions one readily obtains gray discoloration due to reduction to elemental lead. The poisonous character of the lead compounds used in the batch house has been checked to some extent by the recent introduction of prefritted lead silicates and lead borosilicates; but still the ceramist is looking for lead substitutes and especially in these days, leadless glazes are urgently required.

(5) Bohemian Crystal

The equally famous Bohemian crystal glass was developed on a soda-potash basis. The source of the potash originally was the ash of the wood used as fuel; in a later period the residues of molasses were used. This natural potash also contained a certain number of other salts such as sulfates, chlorides, carbonates, and phosphates. The combination of sodium and potassium and the presence of phosphates and chlorides enhanced the meltability of the Bohemian crystal glass. The combination of sodium and potassium is effective by the promotion of workability on the basis of the complexity phenomenon which was discussed with the fourth principle of structural changes. The complete replacement of soda by potash actually would yield harder glasses of shorter working range. The incidental presence of the various salts in the potash is efficient on the basis of most of the other structural changes improving meltability.

The role of these salts was discovered when the potash derived from plants was first replaced by synthetic potash of high purity. One of the most surprising consequences of this replacement was that with pure alkali compounds produced by the chemical industry no alabaster glass could be obtained. Only after the careful analysis of typical Bohemian alabaster glasses which revealed sulfates and chlorides, Macbeth was able to reproduce this type of opal glasses also from pure materials by means of proper additions. How important these accidental impurities were from the viewpoint of the glass melter can be learned from the fact that the chemical industry, in order to introduce their synthetic potash into the European glass industry, finally agreed to add phosphates and chlorides to their pure product.

With respect to chemical resistivity, the use of potassium oxide as a flux deserves particular mention. Sodium-potassium glasses are chemically more resistant than pure soda glasses of equal meltability. In other words, if a glass of definite chemical resistivity is desired, more alkaline flux can be used, when both sodium and potassium are introduced.

(6) Thuringian (Alumosilicate) Glasses

When glass became the material for scientific instruments such as laboratory ware and thermometers, stricter requirements had to be met. The glass had to be more resistant than the customary soda lime glass and it had to stand repeated heating and blowing operations without devitrification. By some mysterious reasons, a type of glass manufactured in Thuringia seemed to be superior and dominated the market for a long time, especially in the field of precision thermometers. Later, the analytical investigation offered a simple explanation. The sand used for glass melting in Thuringia contained feldspar which introduced a small percentage of Al_2O_3 into the glass. This small Al_2O_3 content made the glass more resistant to chemical attack and devitrification. Moreover, it has been found that very small amounts of Al_2O_3 replacing SiO_2 decrease the viscosity of the glass melt.

At present, the addition of small amounts of feldspar, not only in the case of simpler low priced laboratory ware, but also in commercial tank ware is good practice in this country.

The ultimate effect of the partial replacement of Si^{4+} by Al^{3+} is a combination of two opposite consequences of its lower valency:

(a) The hardening effect of the decreased oxygen ratio. (Second Principle.)

(b)) The softening effect of the weaker Al-O bond. (Third Principle.)

At least in higher concentrations the first effect is predominant and the meltability of the glass decreases. The action of feldspar, nepheline, and similar aluminous raw materials is more specific, because they introduce not only Al_2O_3 but provide SiO_2 in a very suitable form.

The efficiency of Al_2O_3 as a means to improve chemical resistivity and to prevent devitrification is now generally recognized. Today there is scarcely a glass batch which does not contain feldspar, nepheline-syenite, aplite, or other aluminous raw materials. In the section on resistiv-

ity the extraordinary protective effect of a small amount of aluminum ions against chemical attack has been discussed.

(7) Jena Resistant Glasses, Pyrex Glass

When Schott studied new oxides as constituents of optical glass he found that the thermal expansion of borosilicate glasses was extremely low. Glasses possessing this property are heat shock proof. In the field of soda-lime silicate glasses the thermal expansion decreases with increasing silica and therefore, low thermal expansion excludes a low melting temperature.

B_2O_3 proved to be a flux which came closest to silica in its expansion properties, as long as not much more than 12% were introduced. In the theoretical part it had been shown, that B^{+++} takes the place of silicon and, with its lower valency, decreases the oxygen ratio, but acts as a flux due to the weak B-O bond. (Third principle.) Unlike in the case of Al, the second effect seems to prevail in the influence on meltability. If more than about 15% B_2O_3 are introduced or in low alkali glasses its fluxing effect is due to the weak triangular arrangement of O^{--} around B. (First Principle.)

With increasing amounts of B_2O_3 present in this triangular configuration, the undesirable high expansion of pure B_2O_3 become apparent.

Due to their excellent properties, the aforementioned borosilicate glasses of the Jena Glass type have been modified in various ways. Additions of both alumina and zinc oxide made the Jena Geraeteglas famous. Zinc oxide can be looked upon as a means of improving the meltability of a glass according to the Third Principle. That is, by replacing silica. In this case zinc oxide lowers the melting range without impairing the chemical resistivity as much as other fluxes like CaO or MgO. In certain respects, it behaves similar to PbO.

An entirely new application of using B_2O_3 as a flux is represented by the development of the Pyrex brand glass. Pyrex glasses are typical high melting glasses. Nevertheless, within the scope of this discussion, they have to be considered as fused silica fluxed by the use of B_2O_3. This fluxing method lowers the melting point of fused silica considerably, but does not deprive it of its outstanding qualities. Similarly, other substances in minor quantities have been used such as Li_2O, As_2O_3 in Pyrex, SnO_2 in Stannosil, ZrO_2, and ThO_2, which involve various of the other principles for decreasing the fusing temperature of silica glass.

(8) The Basis of Enamels and Veritable Colors

A different group of glasses where the low melting temperatures do not represent a convenience but a necessity, are the porcelain enamel frits and the vitrifiable colors. For both purposes a more delicate balanec of properties had to be developed on the basis of borosilicate glasses. (Principles one and three.) A further characteristic means to improve their meltability was the replacement of oxygen by fluorine. (Fifth principle.)

The porcelain enamels are fundamentally different from the old jewelry enamels where a soft paste consisting of lead silicate and a major amount of arsenic had been used. For most purposes, the enamels of today require considerable chemical resistivity as well as meltability.

Another characteristic feature of porcelain enamels is that they present multicomponent systems. Whereas modern commercial glasses can be traced back to a ternary or quaternary system, ten or more constituents are the rule in enamels. This large number of components is generaly believed characteristic of an enamel of good properties. (Fourth Principle)

The modern glass industry, in reorganizing the process of glass melting and abandoning the traditions inherited from father to son, deliberately eliminated minor additions and tried to simplify and economize. Furnace engineering and improved refractories compensated for the steady increase in melting range. In enamels just the opposite trend prevailed. When ZrO_2 was introduced as an opacifier, it was found that this oxide not merely acts as an inert medium causing opacity but that a part of it dissolved in the melt and improved the resistivity of the enamel considerably.

The biggest success in combining resistivity and low melting range of vitrifiable colors was achieved, when the use of colored, especially red, lettering on outdoor gasoline signs and on milk bottles, called for special weatherproof colors. In many cases, these colors were supposed to contain less than the usual amounts of lead and in ideal cases were to be lead-free. The most important chemicals in this development were CdO, TiO_2, and Li_2O.

Originally improved acid resistivity of vitrifiable colors could only be gained by the introduction of more SiO_2. Because of the higher melting temperature of this improved batch it became customary also to increase its B_2O_3 content. This compromise led to colors of medium good resistivity and impaired brilliance.

The first use of the strong fluxing properties of lithia in glasses of high resistivity was made in the vitrifiable colors developed by Eisenlohr in 1929. The basis of these first colors was:

$$\left.\begin{array}{l} .09\ PbO \\ .05\ K_2O \\ .05\ Li_2O \end{array}\right\} 1.5\ SiO_2$$

The flux was introduced in the form of eutectic lithium silicates. A large group of lithium containing vitrifiable colors followed and about 10 years later most of the better resistive colors in the United States contained lithium.

The effect of lithia as a flux is a combination of its stronger disturbance on the $Si\text{-}O_4$ bond and the complexity effect. (Fourth Principle.) The resemblance of lithium to the alkaline earths, as well as its small ionic volume contribute to the chemical resistivity of the vitreous products containing some lithium.

The low melting resistive lithium colors were originally handicapped by two new limitations, their increased expansivity and the tendency of lithium to weaken the decorated glass ware. However, the relatively high expansion coefficient imparted by this alkali is compensated by the fact that less of this flux is required than of any other alkali.

The fast migration of the lithium ions from the colored flux into the decorated glass ware had become a more serious disturbance, since it gave rise to the formation of a glass layer of high expansion and low mechanical strength. But the use of spinel with the pigments

(*Continued on page* 480)

GLASS INDUSTRY ENLISTS IN WAR ON ACCIDENTS

By R. L. CLAUSE
President, Pittsburgh Plate Glass Company
Member of National Committee of the War Production Fund to Conserve Manpower

A blot on our otherwise breath-taking war production record is manpower loss through accidental death and injury. Since America entered the war, an estimated 5,000,000 man-days have been needlessly wasted. More than 43,000 fatalities on or off the job, or nine times more deaths than those reported by our armed services, have cut ruthlessly into our working army.

Not all industries have been affected by a large increase in frequency and severity of accidents. The glass industry is a happy exception to the rule. It enjoys a frequency rate one-half that of the average for all industry, and a severity rate one-third of average.

The glass industry thus is a bright example of the accident-prevention campaign now sweeping the country. What is recognized as good and indispensable for maximum efficiency in one highly developed industrial field, should be encouraged for all arms of industry as a wartime duty.

The National Safety Council, an organization with thirty years' experience in safety leadership, was asked by Presidential proclamation to map a safety strategy covering all phases of accidents on the home front. Business and industry formed the War Production Fund, and set about raising $5,000,000 to make possible the unprecedented increase in supervisory, consultant, and educational activity which accident-prevention on wartime scale entails. William A. Irvin, former president of the U. S. Steel Corporaton, accepted the national chairmanship of the Fund, and is devoting his full time to ensuring its success. Members of the glass industry serving on the Fund's sponsoring committee include:

Royden A. Blunt, vice-president, Buck Glass Company; William Carroll, White Hains Optical Company; J. P. Levis, president, Owens-Illinois Glass Company; M. H. Eisenhart, president, Bausch and Lomb Optical Company; Edwin H. Land, president, Polaroid Corporation; H. P. LeClair, secretary, DuPaul-Central Optical Company, Inc.; Ira Mosher, vice-president, American Optical Company; and George B. Wells, president, American Optical Company.

Between 1929 and 1940 the glass industry experienced a reduction of 43 per cent in frequency of accidents, and a 46 per cent reduction in severity of accidents.

Since that time the glass industry has shared only slightly in the general increase in frequency of accidents that is a by-product of an immense conversion and expansion of all industry under war conditions. The increase in frequency rate in all industry between 1940 and 1941 was eight per cent, but the glass industry showed an increase of only three per cent. This is a testimonial to the relative efficiency of the glass industry, and a warning that constant vigilance must obtain if the trend upward is to resist the general tendency.

The following table places the glass industry in the accident picture better than words:

INDUSTRY	*Frequency changes*		*Severity changes*	
	1940 to 1941	1929 to 1941	1940 to 1941	1929 to 1941
GLASS	+3%	—43%	—45%	—46%
All Industries	+8%	—55%	—8%	—43%
Rubber	+13%	—51%	—2%	—36%
Chemical	+7%	—62%	—50%	—2%
Steel	+5%	—43%	+5%	—28%
Clay Products	+45%	+8%	+50%	+31%
Paper and Pulp	+11%	—52%	+5%	—32%

The glass industry's showing in severity is particularly good, largely because of the comparatively recent 1940 reduction of 45 per cent. Severity rate reductions have been recorded in both large and small organizations, contrary to the rule which generally favors the large establishment. Only incandescent lamp and radio tube manufacturing did not share in this decline in severity.

Of every 20 injuries reported, one developed into a permanent disability, and for every 156 injuries, one fatality occurred, compared with an average throughout all industry of one out of 98. Glass products plants showed the most serious accidents resulting in permanent disabilities — one out of 13. In manufacturing flat drawn glass the score was only one out of 91. However, when a serious accident did strike, the average time lost was high in this latter type of plant — almost 800 days.

In spite of the hazards involved, the glass industry stands fourth in a list of 31 major American industries. This individual record holds promise for all industry. It must be jealously guarded at a time when freedom from accident is not merely a question of local pride and concern, but of grim national necessity. This the glass industry proposes to do, by private effort and by close cooperation with the National Safety Council's war on accidents.

SODIUM NITRATE FURTHER RESTRICTED

After January 1, 1943, sodium nitrate and potassium nitrate will no longer be allocated under order M-62 for the manufacture of glass containers. This includes all tumblers used as containers.

The voluntary cooperation of the manufacturers of glass containers who were requested last spring to omit the use of these materials has been excellent. However, the demand for sodium nitrate has become so great that further curtailment is necessary. Its use for all other glass manufacturing must be kept to the minimum amount.

Research Digest

Practical Interpretations of Glass Technology

Effect of Iron Oxide on Properties of Soda-Dolomite Lime—Silica Glasses

In a recent paper, which is one of a series by means of which they have brought together much useful data on the soda-dolomite lime—silica glasses, the members of the staff of the General Research Laboratory of the Owens-Illinois Glass Company now show the effect of iron oxide on such glasses (Journal American Ceramic Society, October, 1942).

Using two base glasses, namely, A — 16 per cent sodium oxide, 10 per cent dolomite lime, and 74 per cent silica, and B — 14 per cent sodium oxide, 12 per cent dolomite lime and 74 per cent silica, iron oxide was systematically substituted for (a) Na_2O, (b) CaO.MgO, and (c) SiO_2 in amounts of 1, 3 and 5 per cent. The following properties: 1—liquidus temperature; 2—viscosity; 3—deformation temperature; 4—fiber softening point; 5—density; 6—coefficient of expansion; and 7—the chemical resistance toward both distilled water and dilute acid were measured on the resulting series of glasses.

The results obtained indicated that 1—additions of iron oxide increased the density of the glasses; 2—small amounts of iron oxide decreased the liquidus temperature when substituted for SiO_2 while larger amounts (above 3 per cent) increased the liquidus temperature. When it replaced soda an increase was noted for all percentages; 3—the substitution of iron oxide for silica decreases the viscosity, when dolomite lime was replaced the viscosity at high temperatures was increased while at low temperatures it was decreased, the substitution of iron oxide for sodium oxide increased the viscosity. In the case of the other properties that were measured the substitution of iron oxide, did cause some changes, but none were of a startling nature as far as practical glass making was concerned. The reported positive effect of iron oxide on the diathermacy of the glasses and its effect on meltability was not determined.

While the amount of iron used would make the resulting glasses quite green in color the results obtained from this work are quite valuable inasmuch as they bring one closer to an understanding of what can be done to change the physical properties of glass. The results, of course, are of direct interest to those producing colored glasses such as goggles and dark iron colored wine containers.

Cerium in Glass Making

War Production Board Order M-152, recently issued, prohibits the use of arsenic in glass-making as far as the container field is concerned. With other oxidizing agents already out of the picture the container industry is therefore studying the possibility of using rare earth oxidizing agents and decolorizers. The use of cerium oxide as an oxidizing agent has long been known but high cost and the lack of practical information concerning its use has prevented its actual usage. N. Kreidl (Journal American Ceramic Society, March 1942) in a discussion of the rare earths states that cerium oxide in glasses is the strongest oxidizing agent with respect to iron. In combination with neodymium oxide, which compensates the remaining hue, it represents the ideal decolorizer. Arsenic must not be used along with cerium as even traces of it will impair the color of the glass. A bibliography is also included in the paper and it lists several references that are valuable to anyone interested in reviewing the subject of cerium decolorizing.

The Significance of Surface Marks on Fractured Glass

It is being realized more and more that "fracture analysis", i. e., the study of broken glass fragments will give important information concerning the conditions existing at the time of failure of a piece of glass. Preston originally described the information that could be obtained by the study of "hackle-marks" and "rib-marks" several years ago. Murgatroyd (Journal Society Glass Technology, June 1942) now presents the results of a study of the how, where and when of these two types of marks. The results of this study not only elaborate on Preston's original remarks but also give additional proof of the value, both legal and otherwise, of such methods of study.

The reading of this paper in the original is a "must" for all glass technologists, especially those in the container field.

RESEARCH ON CONSTRUCTIONAL RESINS

The staff of Industrial Fellowship founded at Mellon Institute by Westinghouse Electric & Manufacturing Company in 1939 to conduct investigational work on plastics has been carrying on research on new raw materials, new molded products, and new processing methods, evaluating them for commercial application. Particular emphasis has been placed on the use of plastics in those fields where the uses of resinous materials are unknown, limited, or undeveloped.

Following the completion of this basic program, H. Ross Strohecker and William B. Johnston, will conduct the subsequent investigational work. Mr. Strohecker will give attention to the physical technology involved and Mr. Johnston will perfect the chemical processing included in the comprehensive project. These plasticians will have the direct and constant cooperation of experts in the Westinghouse organization.

A.S.M.E. ANNUAL CONVENTION

The American Society of Mechanical Engineers will hold its annual meeting at the Hotel Astor in New York November 30th through December 4th. About 25 papers will be read covering the varied fields of engineering and panel discussions and symposiums will be held with outstanding leaders in each field presiding. The role of engineers in the war effort will dominate the program.

INVENTIONS AND INVENTORS

A Summary of United States Patents of Interest to the Glass Industry Issued During October

Compositions

A patent was granted to Harold R. Moulton of Southbridge, Mass., on the basis of an application in which it is stated that the literature, as far as is known, makes no mention whatsoever of any glass making use of the chemical element cadmium. The patent, 2,298,746, assigned to American Optical Co., covers glasses containing the following ingredients:

CdO (cadmium oxide)	50 to 80%
B_2O_3 (boric oxide)	20 to 50%
$BeCo_3$ (Beryllium carbonate)	5 to 20%

together with minor quantities of ingredients which promote fusion, such as alumina, and alkalies or alkaline earths. These are reported to be clear glasses having high indices of refration and other properties desirable in optical glass. Alumina may replace all or part of the Beryllium carbonate to modify thermal expansion and certain optical properties.

Furnaces

In patent 2,299,608 assigned to the Carborundum Co. by Henry H. Blau and Kenneth K. Knaell it is reported that in tanks made of fusion cast refractories, seepage of glass between the joints of the blocks is a serious problem. This could be more serious with the cast blocks than with less dense blocks due to their higher thermal conductivity which tends to keep the seepage at a higher temperature and sometimes unfrozen. To attack this problem Blau and Knaell propose various means of keeping the joints cool. For example, in Fig. 1 they have had the blocks molded with a groove on the side of each

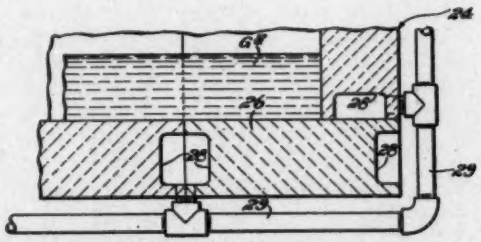


Fig. 1. 2,299,608: Blau and Knaell, Cast tank blocks with grooves which form a passage, 28, for air cooling.

so that two grooves are paired together at a joint to form a passage 28 through which air can be circulated for cooling.

The same basic problem of making a leak-proof tank is dealt with by Enoch T. Ferngren of Little Neck, N. Y., in patent 2,299,084, but he aims to avoid cooling the tank because of the loss of expensive heat units which this entails. He plans rather to seal and insulate the furnace in some such manner as is illustrated in Fig. 2. The tank blocks 16 are joined and backed with a material of glass-like composition 28 which must have a melting range somewhat above that of the glass to be melted in the

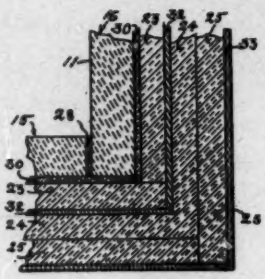


Fig. 2. 2,299,084: Ferngren. To seal an insulated furnace hearth, the blocks are joined with a glass sheet 28, and a heat-resisting metal sheet 32 is placed within the wall.

furnace. Its composition must be such as to maintain it in a semiplastic condition when the furnace is operating. However to assure a good seal the tank should be pre-heated to a high temperature before any glass batch is melted in the furnace.

Referring to the remainder of the construction of Fig. 2, the tank bloks are backed up with porous refractory insulation. Other elements of the sealing plan are the provision of a heat resistant steel sheet 32, within the wall, and a steel casing on the outside.

Feeding, Forming and Shaping

The plan of a new continuous forming machine for containers, invented by Leonard D. Soubier and August E. Scheuerman of Toledo, is indicated by Fig. 3 from their patent 2,298,728 assigned to Owens-Illinois Glass Co. The machine is provided with an endless chain type of conveyor for the neck molds which advances the ware from start to finish of the forming machine, coming successively to similarly borne blank molds, intermediate blowing molds and finishing mold. Charges are picked up by suction from the forehearth 26 by the neck mold units moving to the right. The endless neck mold conveyor moves successively around rotary supports 31, 32, 36 and 35. Carried by similar but shorter conveyors are blank molds on rotary supports 31, 32, intermediate molds on supports 41, 42, and finishing molds on 36. As the neck molds reach the rotary support 31 they are brought into register with blank molds which close about the former and travel with them during the gathering of the charge. Thereafter an intermediate mold 38 (upper conveyor) closes about the parison and neck mold and travels with them while air pressure blows the parison to hollow form within the intermediate mold. As the latter approaches the large finishing mold carriage at the right, it is opened, again leaving the bare parison suspended from the neck mold. Then a finishing mold encloses the parison and the container is blown to final form while still supported in the neck mold. Finally the finishing mold and the neck mold open, and the ware is deposited on a conveyor 44, shown at the bottom of Fig. 3.

Patent 2,299,488 assigned to Samuel M. Dover of Chicago by James A. Moorehead of Huntington, W. Va., describes a mold for pressing lenses.

Miscellaneous Processes

A method of frosting the interior of electric lamp bulbs is related in patent 2,297,981 granted to Marvin Pipkin of

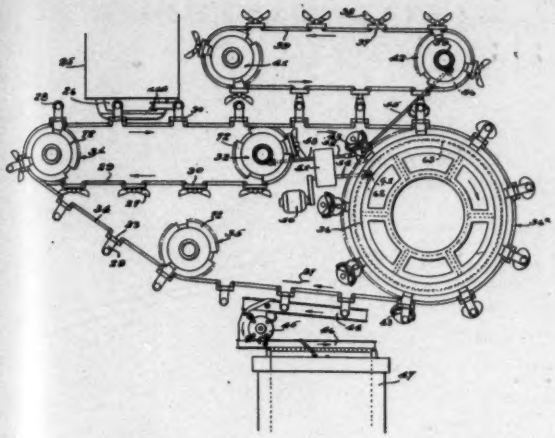


Fig. 3. 2,298,728: Soubier and Scheuerman. A container forming machine in which the neck molds, carrried on a continuous chain conveyor receive the charge from forehearth, 26, and are in register successively with blank molds, intermediate molds and finishing molds, carried on other conveyors.

Cleveland Heights, Ohio. Lead bird shot is poured into a bulb to fill it about half full, and then an etching solution of hydrofluoric acid is added. In five or ten minutes this gives a desirable uneven etch with peaks where individual lead shots touched the surface. Sometimes the etched half of the bulb is then paraffin coated to give it protection while a light etching is applied to the remainder. This is a General Electric patent as are 2,298,-968 granted to Willard A. Roberts and Hannah T. Geissbuhler of Cleveland, and 2,299,750 granted to Albert W. Hull and Roy W. Moore of Schenectady. The Roberts-Geissbuhler patent concerns the application of a fluorescent coating to a lighting unit by suspending the fluorescent agent and ½ to 15 per cent boric acid in a liquid binder, spraying it onto the glass surface, and applying heat to volatilize the binder and to convert the boric acid to boric oxide. The Hull-Moore patent covers a means of making a composite article in which a metal conductor is joined to a glass bushing.

A glass to metal seal in which the metal is preheated in a hydrocarbon gas is the subject of 2,298,974 assigned by George R. Shaw of Verona. N. J., to RCA. The metal, such as nickel plated iron wire, then generates gas during the sealing operation so that the bond between glass and metal is less continuous and therefore, according to Shaw, less apt to crack.

Other patents issued during October are 2,298,496 to R. F. Metzger of Glendale, N. Y., for a lens grinding machine, 2,298,295 to Chas. S. Hyatt and John C. Lowman of Columbus, Ohio (Columbus Coated Fabrics Corp.), for an impervious coated glass cloth, and 2,299,-552 to Robt. R. McGregor and Earl L. Warrick of Mellon Institute, Pittsburgh (Corning Glass Works), for the preparation of a coating of the vinyl acetate type to be used on glass blocks to prepare them for taking a mortatr.

Sheet and Plate Glass

The August 1941 issue of GLASS INDUSTRY reviewed patent 2,244,715 in which Bernard Long of Paris, France (The American Security Co.) revealed his idea for a tempered windshield plate in which numerous small areas are only moderately tempered. The purpose is to reduce the completeness of shattering in case of an accident, so that the driver's view will not be completely obscured. The apparatus for obtaining this differential tempering has now been described in patent 2,298,709. The sheet heated for tempering is subjected simultaneously to air blast from both sides, applied through a blowing frame which has many tiny blowing holes. Within the pattern formed by these holes are screens or pads which may be adjusted to any distance from the glass, even to actual contact, so that the severity of cooling and of tempering will be lessened in these areas.

Fig. 4 from George W. Batchell's patent 2,297,737 indicates the manner in which he proposes to minimize the wave lines or batter in vertically drawn sheet glass. To alter the air currents in the area surrounding the newly formed sheet he provides heat-resisting metal reflector plates 45 extending across the width of the sheet. Their positions may be altered from without the furnace by raising or lowering the pivoted refractory blocks 20, 21, on which their lower edges rest, and by adjusting the hollow rods 47 from which the reflectors are suspended. The glass sheet does not actually touch the reflectors but only a small clearance is maintained.

An edge grinding machine for windshields and other small plates is described in patent 2,299,850 issued to Conrad B. Schafer of Toledo and Edward Oberstar of Ottawa, Ill. (Libbey-Owens-Ford Glass Co.). Another Libbey-Owens-Ford patent is 2,299,827 granted to Melvin C. Koester of Toledo for a means of attaching glass pulls or handles to sliding doors made of laminated glass. The glass laminae are put together with a resin bonding layer, given a preliminary pressing, the pull laid in place with a small sheet of plastic under it, and then the entire laminated unit with glass pull is subjected to hydraulic pressure to complete the bonding process.

In a laminated sheet for wall windows Brook J. Dennison and Frank F. Painter (2,298,874 to Pittsburgh Plate Glass Co.) provide a flexible sheet metal mounting strip of which one edge is embedded and anchored in the plastic interlayer.

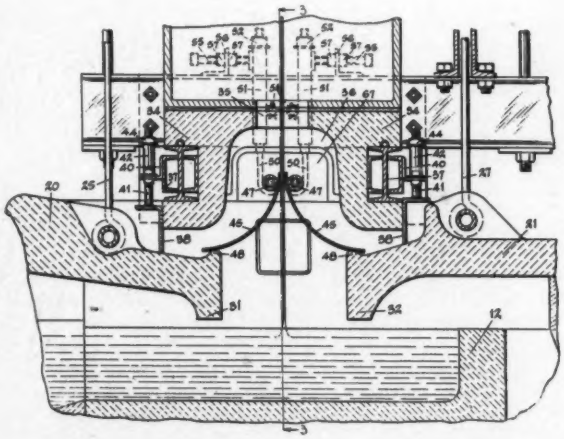


Fig. 4. 2,297,737: Batchell. Reflector plates 45 to minimize waviness by sealing off the forebay in a sheet drawing machine.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	50.00	55.00
Precipitated material		55.00	60.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o b. shipping point	ton	15.00–16.00	18.00
Borax ($Na_2B_4O_710H_2O$)			
Granulated	In bulk, ton	32.50	....
Granulated	In bags, ton	46.00	56.00–61.00
Powdered	In bags, ton	50.00	61.00–66.00
Boric acid (H_3BO_3)			
Granulated	In bulk, ton	96.50	
Granulated	In bags, ton	100.00	111.00–116.00
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.09½–.09¾	.10
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00–13.25	
40 mesh	ton	11.50–13.75	
Granular	ton	11.75–14.00	
Semi-granular	ton	11.00–13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags.			
Fluorspar (CaF_2) domestic, ground, 96–98% (max. SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	34.00	....
In bags	ton	36.40	50.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0900	....
In 5 Ton lots	lb.	....	.0950
Less than 5 Tons	lb.	....	.10
Lime—			
Hydrated ($Ca(OH)_2$–MgO) (in paper sacks)	ton	8.50	9.50
Burnt (CaO–MgO) ground, in bulk	ton	7.50	....
Burnt, ground, in paper sacks	ton	9.50	9.50
Burnt, ground, in 191 lb. gross drums Per drum		1.70	1.80
Kiln Dried ($CaCO_3$–$MgCO_3$) 10x30 mesh	ton	2.00	....
Kiln Dried ($CaCO_3$–$MgCO_3$) 16x20 mesh	ton	2.00	....
Nepheline Syenite, f. o. b. shipping point	In bulk, ton	12.00	15.00
Potassium carbonate—			
Calcined (K_2CO_3) 96–98%	lb.	.065	.0675
Hydrated 80–85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4) in bags	ton	21.00–22.00	28.00 30.00
	in bulk	17.50	
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In Paper bags	Per 100 lb.	1.10	
In Burlap bags	Per 100 lb.	1.15	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls. 95% and 97%	Per 100 lb.	....	3.00–3.40
Bulk	Per 100 lb.	1.35	3.60–4.00
200 lb. bags		1.4675	....
100 lb. bags		1.5025	....

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.031–.034	.045
Aluminum oxide (Al_2O_3)		.07	.09
Antimony oxide (Sb_2O_3)	lb.	Open price	.15½–.17½
Arsenic			
Glassmakers	lb.	.04¼	.04¾
Regular refined white	lb.	.04	.04½
Arsenic trioxide (As_2O_3) (dense white) 99% In barrels		.04–.04¼	.04½–.04¾
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite (20% Al_2O_3)	ton	10.00	13.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.06	.08
Tin Oxide (SnO_2) in bbls	lb.	....	Open price.
Titanium Oxide (ceramic grade)			
In bags	lb.	.14½	....
In barrels	lb.	.14¾	....
Zinc Oxide (ZnO)			
American process, bags	lb.	.07¼	.07½
White Seal, 150 lb. bbls	lb.	.09¾	.10
Green Seal, bags	lb.	.09	.09¼
Domestic White Seal, bags	lb.	.09½	.09¾
Red Seal, bags	lb.	.08½	.08¾
Zircon			
Refined Granular (Milled .01–.02c higher)		.05¾	.06

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40–1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.10–1.15
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls	lb.	....	.25–.28
Chromite (99% through 200 mesh)	ton	58.25	64.75
Chromite ore (air floated)	ton	58.25	64.75
Cobalt oxide (Co_2O_3)			
In bbls.	350 lbs. or more, lb.	....	1.84
	Less than 350 lbs., lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.20–.22
Black (CuO)	lb.	....	.19–.22½
Black prepared	lb.	....	Open price.
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.06½–.10
Black (Fe_3O_4)	lb.	....	....
Iron Chromate	lb.	....	.035–.05
Lead Chromate ($PbCrO_4$) in bbls.	lb.	....	.16
Lithium Carbonate	lb.	....	1.25
Manganese, Black Oxide African			
In Paper bags	ton	70.00	78.00
In Burlap bags	ton	71.75	79.75
In Casks	ton	74.00	82.00
Neodymium oxalate, 50 lb. drums	lb.	....	4.00
Nickel oxide (Ni_2O_3), black	lb.	....	.34–.40
Nickel monoxide (NiO), green	lb.	....	.35–.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.09½	.09¾–.10
Powdered	lb.	....	.10¼–.10½
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.21–.25
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) in 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07¼	.07½–.07¾
Sodium chromate (Na_2CrO_7) Anhydrous	lb.	.08⅝	.08¾–.09⅛
Sodium selenite (Na_2SeO_3)	lb.	....	1.50–1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.65
Yellow	lb.	....	1.65
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.40	3.75–4.15
Flowers, in bags	Per 100 lb.	3.05	3.40–3.80
Flour, heavy, in 250 lb. bags	Per 100 lb.	2.95	3.30–3.70
Uranium oxide (UO_2) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	....	2.15
Yellow orange	lb.	....	1.65

Polishing Materials

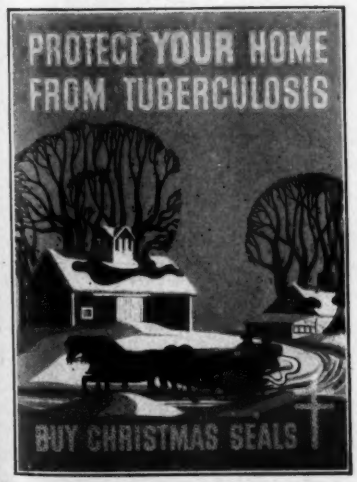
		Carlots	Less Carlots
Pumice Stone,			
American Ground FFF, FF, F	lb.	.04	.04½
0, 0½, ½, 1	lb.	.05	.05½
Putty Powder	lb.	Open price.	
Rotten Stone (Domestic)	lb.	.02¼	.03½
Rouge, Red	lb.	.18	16
Black	lb.	.15	.18

NEW EQUIPMENT AND SUPPLIES

NEW G-E BOWED-IN REFLECTOR

The General Electric Company's new L-43 floodlight features a bowed-in silvered-glass reflector which is the equivalent of a larger floodlight in its utilization of light. Due to its shape, light reflects back to the parabolic surface where it is redirected outward as part of the main beam. The reflector serves also as the floodlight casing and is made shatter resisting by an extra coating of electrolytically deposited silver. A standard 1000 watt general service lamp is used with the unit.

The new floodlight is particularly useful for protective lighting, railroad lighting, general area lighting, and lighting for construction work. The possibility of light escaping upward can be reduced by the attachment of a metal visor to the metal rim of the door, the visor swinging out with the door when it is necessary to service the floodlight interior.



SCREW CONVEYOR FEED IMPROVES DUST COLLECTOR UNIT

In 1941 the American Foundry Equipment Company introduced the American Wet Disposal Unit, designed to make a wet sludge of the dust discharged from the hoppers of dry type dust collectors by centrifugally mixing the accumulated dust with water or other liquids. The dust, entering the unit at the same time as the liquid which discharges at the center of a high-speed mixing disc, mixes so instantaneously that it does not disperse into the atmosphere.

By the addition of a screw conveyor the unit has been improved to include a constant and uniform rate of feed of discharged dust from dry type collectors to the sludge forming device. Dust which falls from the dust collector hopper through a flexible coupling is deposited directly into the screw conveyor of the unit. The rate of feeding into the mixing chamber is controlled through gear speed reducer and variable speed motor pulley. The consistencyof the sludge may be controlled by the volume of dust and water fed into the unit.

CATALOGS RECEIVED

Hauck Manufacturing Co., Brooklyn, N. Y. Complete information regarding the Hauck Proportioning Burner for precision control of temperature and atmosphere in heating applications is given in their new 16 page catalog. Diagrams for automatic control hookups and installation pictures are included.

Leeds & Northrup Company, Philadelphia, Pa. "Micromax Thermocouple Pyrometers," revised in 56 well-illustrated pages, gives war-time pyrometer users first-hand information on available indicators, recorders and controllers, including thermocouples and accessories to be used with them. The book contains a comprehensive description of the application of balance-type pyrometers.

The Chemical Engineering Catalog, twenty-seventh annual edition (1942-1943), containing concise and accurate information as to equipment, supplies and raw materials, is now available. The book section has been brought up to date and constitutes a complete bibliography of chemical technology. Also listed in this standard reference book is an alphabetical list of the firms represented therein and a Trade Name index.

LIFT TRUCKS SUSTAIN HIGH PERFORMANCE

Many years of performance have shown a record far exceeding expectations for the HydroLectric motorized hand lift truck manufactured by Lift Trucks, Inc. In the early days 8 hours' operation a day for electric trucks was considered a fair test. As against this standard the HydroLectric handled average loads of 5000 pounds continuously from 20 to 24 hours. Three of the original trucks are still in operation with records of 12 years on the basis of an 8 hour service.

W. C. Stuebing, president of the company, claims that the unusual performance is attributable to correct design, sturdy construction and thirty years of manufacturing and engineering experience. He also claims they may be operated by any inexperienced man. Maximum loads are lifted through a powerful hydraulic ram. By pressing the patented finger control, heavy loads are moved forward or backward without effort.

Acheson Colloids Corp., Port Huron, Michigan. Bulletin No. 421-Z, a new 4 page booklet, shows the use of "dag" colloidal graphite as a lubricant for running-in internal combustion engines, compressors and other mechanical equipment.

The Hays Corporation, Michigan City, Indiana. Bulletin 42-552 illustrates and describes Hays instruments and controllers used in the ceramic industry. An application of automatic combustion control to a gas fired glass furnace and a centralized control panel is shown in blueprint, with a detailed explanation of both.

B. F. Goodrich Company, Akron, Ohio. A practical booklet entitled "Rubber Conservation for users of Industrial Rubber Belting" shows how worn conveyor belts can be salvaged and how by proper care rubber can be given longer life.

CATALOG & BULLETIN SERVICE

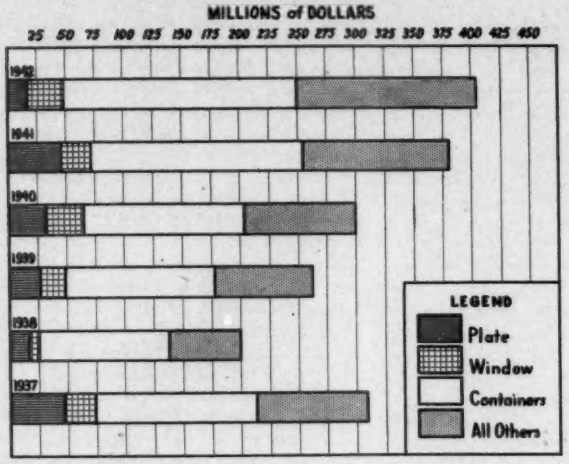
Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

Buy War Bonds

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX

Production: Ten Months, January Through October



During October the glass industry showed an increase in production, payrolls and employment over the previous month. According to The Glass Industry Production Index output during October 1942 totalled $42,000,000 bringing this year's 10 months' figure up to $405,000,000 as compared to $383,000,000 last year. The total for October 1941 was $45,000,000.

Plate glass production during October totalled 4,932,899 sq. ft. according to the Plate Glass Manufacturers of America. This was an increase of 4 per cent over the previous month's total and 68 per cent below the volume reported for October 1941. During the first 10 months of this year plate glass output amounted to 52,636,434 sq. ft. as compared to 165,815,948 sq. ft. produced during the same period in1941, a decrease of 68 per cent.

Window glass actual production figures for the month of October are unavailable since the Association would not release this data for publication at press time. However The Glass Industry is informed that production of window glass is probably slightly higher than the corresponding month a year ago. Production for the month of September 1942 was 1,096,883 boxes. An increase of only one per cent would make October production approximately 1,107,851 boxes. This same rough estimate of increase applied to the cumulative figures for the January-October period would make a total of 12,559,194 boxes produced.

Glass container production during October totalled 6,837,375 gross, as reported by the Glass Container Association of America. This represented an increase of 8.5 per cent over the previous month and a decline of 3.6 per cent from October 1941. During the first 10 months of 1942 the total was 66,166,901 gross, an increase of 14 per cent over the same period in 1941.

Shipments of glass containers during October increased approximately 12 per cent over the October 1941 total and very slightly over September 1942, to 6,974,550 gross. However, the cumulative total for the January-October period of 1942 increased to 66,369,792 gross or 13 per cent greater than in January-October of 1941.

The outstanding gains over October 1941 were: fruit jars—201 per cent; beer bottles—50 per cent; wide mouth food containers—43 per cent. The major increases over 1941 on the 10 months basis were: beer bottles, 98 per cent; domestic fruit jars, 63 per cent; wide mouth food containers, 27 per cent.

Inventories of glass containers for October totalled 8,299,100 gross—4 per cent greater than last year.

Miscellaneous glass products manufactured in September were valued at 16,000,000, the same figure as of October 1941. During the first 10 months of 1942 production in this branch of the industry totalled $152,000,000 as compared to $155,000,000 for the same period in 1941, a 2 per cent decrease.

According to a preliminary report of the Census Bureau, ten illuminating glassware manufacturers reported October sales totalling $717,000 which was 8

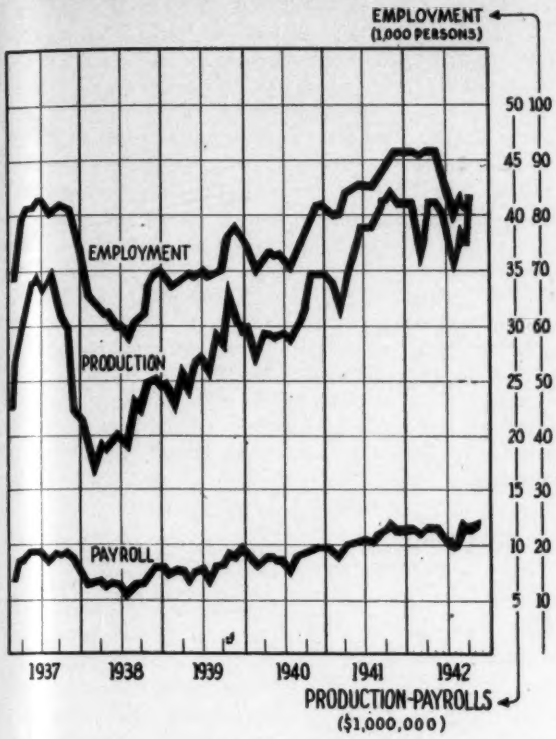
CURRENT GLASS CONTAINER STATISTICS

(All Figures Are Gross)

	Production		*Shipments*		*End of Month Stocks*	
Classifications	*Oct. 1942*	*Oct. 1941*	*Oct. 1942*	*Oct. 1941*	*Oct. 1942*	*Oct. 1941*
Food Containers (Narrow Neck, Wide Mouth and Pressed)	2,309,091	1,843,033	2,384,000	1,685,979	2,278,062	1,912,112
Pressure and Non-Pressure Ware	377,587	386,644	349,822	310,291	341,967	518,766
Beer Bottles	684,975	324,725	617,563	407,625	346,519	404,242
Liquor Ware	1,238,950	1,454,489	1,171,165	1,042,318	1,541,126	1,709,249
Medicinal and Toilet Ware	1,383,595	2,115,535	1,662,043	2,021,687	2,685,136	2,419,078
General Purpose	444,682	481,309	454,840	463,838	579,439	406,537
Milk Bottles	298,229	337,612	276,454	285,474	345,413	339,403
Fruit and Jelly	70,759	50,527	28,860	9,715	149,342	198,705
All Other	29,507	21,939	29,803	16,731	32,096	39,526
Total Industry	6,837,375	7,015,813	6,974,550	6,243,658	8,299,100	7,947,618

THE GLASS INDUSTRY'S INDEX

Monthly Trends Through October, 1942



per cent under October 1941, but 28 per cent over the September 1942 total.

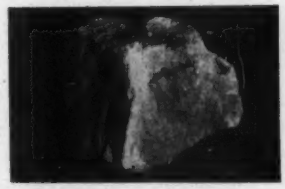
Automatic tumbler production during October amounted to 4,499,780 dozens, or a 7 per cent decrease from last year's corresponding month. The January-October figures totalled 43,336,644 dozens, as compared to 44,001,910 dozens of last year during the same period. Shipments for this October decreased only one percent from last year's figure to 4,888,191 dozens and increased 29 per cent over the September 1942 total. Total shipments for January-October 1942 were 43,586,691 dozens and 2 per cent below the same ten months period of 1941. Stocks on hand amounted to 7,836,700 dozens for October, a total showing an increase over that of October 1941.

Manufacturers sales of machine-made table, kitchen and household glassware during October increased one per cent over a year ago to a total of 4,607,812 dozens. For the 12 months period ending October 30 this trade amounted to 40,846,021 dozens as compared to a total in October 1941 of 38,715,696 dozens.

Employment and Payrolls: Employment in the glass industry during October totalled 81,000 persons, the same number as last month and lower than the figure for October 1941, which was 93,000 persons.

Payrolls in the glass industry during October amounted to $12,000,000 as compared to $11,000,000 in September and $13,000,000 in October 1941. During the first ten months of the year glass manufacturers paid out about $119,500,000 in wages as compared to $109,000,000 in 1941 over the same period.

THIS LITTLE PIECE
OF DOLOMITE LIMESTONE



HELPS MAKE THE GLASS THAT
PROTECTS THE ARMY FOOD

Our army needs glass for food containers, table ware, laboratory equipment, and for windows of ships, planes and buildings.

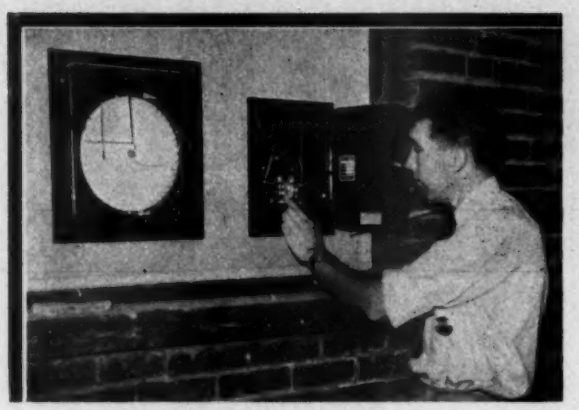
In civilian life, glass continues to play a very important part. It is replacing many critical materials in which there are shortages. Research men are finding more and more amazing possibilities with glass—glass that will float, glass spun into cloth, glass that bends and glass that will stop a bullet,

Lime and Limestone are as essential in the making of glass as they are in the essential industries of STEEL, BUILDING, AND AGRICULTURE.

THAT'S WHY *Banner Lime* IS

Essentially yours

NATIONAL MORTAR AND SUPPLY COMPANY
Grant Building, Pittsburgh, Pa.
Since 1907 . . . A good company to do business with



Hays Pressure Recorder and Automatic Pressure Controller in the plant of The Trenton Potteries, Trenton, New Jersey, manufacturers of the famous DURACLAY Sanitary Ware.

CONTROL
And You **SAVE!**

. . . Save in time, materials, fuel, man-power; minimize spoilage and guarantee a better, more uniform product.

Hays Instruments for the Ceramic Field include air and gas measuring, indicating and/or recording gages, draft and pressure indicators and recorders, gas-air ratio meters, oil-air proportioning meters, combustion meters (CO_2 Recorders) and complete systems of Automatic Combustion Control.

Bulletin 42-552, just off the press, explains the application of Instruments and Controllers to Ceramic furnaces, glass tanks, pottery kilns and enameling furnaces with schematic drawing of a complete system of Automatic Control of combustion and pressures. Sent free upon request.

Send for this TELL-ALL BOOK—*Ask for* BULLETIN 42-552

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

INSPECTORS NEEDED BY U. S. MARITIME COMMISSION

Expanded construction of cargo and war-purpose ships and materials for outfitting them is creating a demand for additional qualified inspectors. Persons with industrial experience are being sought by the U. S. Civil Service Commission for inspection of metals, furniture, mechanical equipment, electrical equipment, silverware, aluminum ware, stainless steel and wooden galley utensils, china, glassware, hospital instruments, hand tools, micrometers, gauges, thermometers, cameras, binoculars, and a variety of portable mechanical equipment. Appropriate experience in inspection or testing is desirable. Broad production experience in the manufacture of mechanical or electrical equipment, or as a journeyman machinist or toolmaker, is acceptable.

Inspectors are also desired for various types and grades of marine paints and paint products.

There are no age limits for these positions. No written tests are required. Applications are not desired from persons engaged in war work unless resulting in a higher utilization of higher skills.

ARTHUR P. TAYLOR, PRESIDENT OF CHAS. TAYLOR SONS CO., DIES

Associated with the Chas. Taylor Sons Company almost since its founding, Arthur P. Taylor, president and treasurer, died at Christ Hospital in Cincinnati on October 15.

Mr. Taylor, long a prominent figure in the refractory industry, was a charter member and past president of the American Refractories Institute, a member of the Cincinnati Country Club, the Queen City Club, and a distinguished member of the Masonic Order. He also served as a Director of the Cincinnati Bank & Trust Company and was a member of the Board of Columbia Life Insurance Company.

CHARLES J. GILL

Announcement has been made of the death on November 12th of Charles J. Gill, president of the Gill Clay Pot Company of Muncie, Indiana. Mr. Gill has been widely known for many years in the glass and refractory business.

The Original Gill Clay Pot Company was started in 1882, and in 1908 Mr. Charles J. Gill, together with Chas. O. Grafton, purchased the interests of his brothers in the company. He has been president of the company since that time. His son, John H. Gill, is Secretary and General Manager of the company.

LEO C. HECKLER

Leo C. Heckler, General Superintendent of the Lynch Corporation of Anderson, Indiana, died on November 6th. Direct in his approach to issue, Mr. Heckler was a leader in his work and in every phase of activity in Anderson, including The American Legion, the Chamber of Commerce and Council.

HAROLD BOESCHENSTEIN HEADS NEW C.M.P. DIVISION

Announcement has been made of the appointment of Harold Boeschenstein, president and general manager of the Owens-Corning Fiberglass Corporation, as Director of the Controlled Materials Plan Division and Chairman of the Controlled Materials Board.

Mr. Boeschenstein was born in Edwardsville, Illinois, in 1896. Following his graduation in 1920 from the College of Commerce and Business Administration of the University of Illinois he began his business career with the Edwardsville Bank and Trust Company. A short time later he became manager of an affiliate of the Illinois Glass Company, which was his first connection in the glass business in which he has remained ever since.

W. C. Skuce, supervisor of materials procurement, priorities and inventory control for the General Electric Company, has been appointed Assistant Director.

Mr. Boeschenstein and Mr. Skuce will work in close cooperation with Hiland G. Batcheller, Arthur H. Bunker and Harry O. King, directors, respectively, of the three controlled materials divisions—steel, aluminum and copper—and with the control officers of the claimant agencies.

The Controlled Materials Plan Division will operate under the general direction of the Deputy Director General for Distribution, J. A. Krug and will include the offices of the Director and Assistant Director, a Controlled Materials Board and an Engineering Board of Review. The Controlled Materials Board will be composed of representatives of the Army, Navy, Maritime Commission, Lend-Lease Administration, Board of Economic Warfare, Office of Civilian Supply, the chiefs of the Aluminum, Copper, Steel, Program and Facilities Divisions, a labor representative and a representative of the Resources Division.

Also established within the new division are a Scheduling Methods Branch, an Instruction, Inquiry and Service Branch and an Operations Branch. The CMP Division will be the agency charged with development and administration of the operation.

An extensive campaign of public education in the operating details of the Controlled Materials Plan is being worked out jointly by the CMP Division and the Division of Information of the War Production Board. The Plan will not be operative until the end of 1943, but it is important that those war producers who will be included under it become thoroughly familiar with its requirements, in order that they may draw their "bills of materials" for presentation to the several claimant agencies. It is on the basis of the "bills" that allotments of controlled materials will be computed.

GLASSMAN WANTED

The Building Materials Division of the War Production Board seeks the services of a man familiar with glass manufacture and various uses of glass. An intimate knowledge of glass used for building purposes such as window, plate, wire and glass blocks is particularly desirable. However, anyone having a general experience in flat glass manufacture will be considered. Salary $3800 to $4600 per year, depending on the individual's background and experience. Address E. M. Lurie, Chief, Gypsum, Roofing and Insulation Products Section, War Production Board, Washington, D. C.

SILVERED-GLASS SUBSTITUTED FOR ALUMINUM IN REFLECTORS

A savings of over 360,000 pounds of aluminum in the manufacture of street lighting equipment and of over 200,000 pounds in protective lighting devices such as searchlights and floodlights has been effected by the General Electric Company by substituting silvered-glass for aluminum in reflectors. The efficiency of these units has been increased from 10 to 30 per cent.

In the manufacture of street lights, the glass reflector and globe are blown as one piece, the reflector is then silvered, and the backing is copper-plated electrolytically. The copper backing offers shatter-resistance for the glass as well as excellent protection from internal heat and the weather.

Silvered-glass reflectors designed with metal casings have the silver baked between a layer of glass and a layer of poreclain enamel which forms an extremely durable backing for the silver. Glass reflectors used without a metal casing also use a poreclain enamel backing which is protected by a copper-plated backing.

LIGHT LOSS LESSENED

As the result of a new chemical process the Libbey-Owens-Ford Glass Company has developed a glass which reduces loss of light from reflection to less than one per cent. The lessening of light loss from this cause is not a new discovery in the industry, but the new method is apparently more practical. A chemical film is applied to both sides of the pane of glass, the film being only six millionths of an inch in thickness and causing no distortion of vision. The film "captures" the light rays which would ordinarily be reflected and adds them to the transmitted rays for their exit through the end surface or other side. Glass having this chemical treatment is not yet on the market.

ALIEN PROPERTY CUSTODIAN CONTROLS STOCK OF AMERICAN POTASH & CHEMICAL CORP.

Over 480,000 shares of stock in the American Potash & Chemical Corporation owned by foreign nationals have been taken over by Leo T. Crowley, Alien Property Custodian. The action, which involves approximately 90 per cent of the stock of the Corporation, as stated by Mr. Crowley "implies criticism of the present officers and directors of American Potash & Chemical Corporation who have a long record of successful management and who will continue in charge of the Company's business".

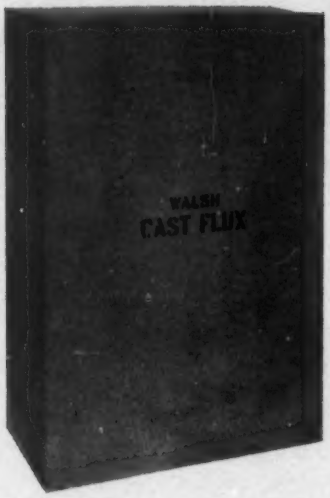
The following statement has been made by Mr. F. Cecil Baker, President of the American Potash & Chemical Corporation in connection with the vesting order:

"American Potash & Chemical Corporation some months ago reported to the United States Alien Property Custodian in Washington certain circumstances and rumors which appeared to indicate that a block of the Company's stock had been acquired by German nationals.

"An investigation by Government officials cooperating with Corporation executives disclosed that approximately 480,000 shares of American Potash & Chemical Corporation stock probably are being held in Europe for the benefit of certain German interests.

"The stock in question was sold by Consolidated

WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage. higher quality glass, freedom from defects. longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street

St. Louis Missouri

Gold Fields of South Africa, Ltd., a British Company which had been responsible for the financing and development of the Trona enterprise since its inception in 1913, to Hope & Company of Amsterdam, one of the most respected banking houses in the Netherlands. This sale took place in 1929.

"Since the sale of this stock the officials of the American Potash & Chemical Corporation have been assured many times by Hope & Company that none of it was being held for the benefit of German interests.

"The Alien Property Custodian announced today that there are no grounds for criticism of the present officers and directors of American Potash & Chemical Corporation who he stated have a long record of successful management and will continue in charge of the Company's business.

"The Company is engaged in the production of heavy chemicals and is playing an outstanding part in meeting the Nation's war demands for critical materials.

"Approximately 450,000 tons of industrial chemicals will be produced by the Company's plant at Trona, California, this year, with an estimated production of some 500,000 tons next year.

"Of this tonnage 70 per cent or more has gone into war production and the balance to satisfy essential civilian needs."

SILICA STONES . . .

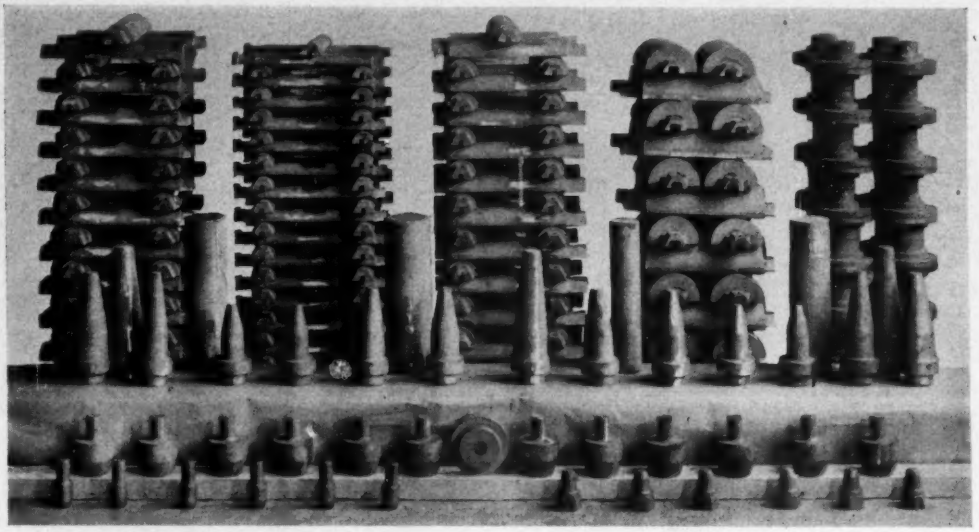
(*Continued from page* 462)

Resistance to Internal Pressure

Samples having A and C type stones were selected in the same manner as was used in the thermal shock test and were tested with the Preston Sustained Pressure machine. Two test levels were used, namely, 200 psi/min at which pressure only a few bottles broke and 500 psi/min at which pressure 100 per cent breakage was obtained. At the 200 psi/min level no apparent difference in the percentage breakage with either type of stone was observed. The breakage at both levels was examined for the location of the initial fracture, the origin and the type of fracture. In all cases the origin and type of fracture were typical pressure failures and in no case did it originate in a stone or stone area. Some secondary fractures did run through a stone or stone area. In this test also, the only conclusion that can be drawn is that the stone or stone area was not weaker than the weakest part of the bottle.

Conclusions

The negative results obtained with this particular style bottle and its particular type and kind of stones in the thermal shock and pressure tests indicate the need for additional work on the subject. Until this is obtained each and every stoney condition must be investigated for its influence on the strength of the container. The results of the impact test are of greater interest as they definitely show that stones, especially silica, if located near the inner wall of the container materially decrease the strength of the container towards impact and that this decrease in strength is due to conditions similar to those obtained in internal scratching.



PERFORMANCE

builds satisfied customers

• "You will be interested in knowing that as time goes on, we are getting more and more life out of Gunite neck rings."

So writes one of the largest users of Gunite mould equipment concerning his experience with Gunite neck rings.

High performance of glass mould parts such as neck rings doesn't just happen—it is the result of years of metallurgical research and expert foundry practice developed to meet the particular requirements for glasshouse castings.

Gunite Foundries has developed a metal best suited for every type of glasshouse mould use. Miller plungers and guide rings, neck ring sticks, bushing stock, press and blow moulds.

We can meet any of your requirements for mould equipment . . . why not prove the value of all our castings by trying Gunite neck rings now. Write us today for prices and details.

GUNITE FOUNDRIES CORPORATION

ROCKFORD - - - - - ILLINOIS

Founded 1854

LOW MELTING GLASSES . . .

(*Continued from page* 467)

incorporated to retain the lithium ions in the color layer had been proposed as a remedy by Weyl and very recently Ablard presented experimental evidence that lithium colors of relatively low expansion and no adverse effect on the strength of the outer layer of the glassware can be manufactured.

It may well be stated that after two years of doubt and attempts to eliminate lithium from vitrifiable color composition the continued use of lithium seems advisable and probable.

The necessity to furnish fool-proof acid resistant colors stimulated the development of low melting glasses for this purpose on an entirely different basis, namely, the introduction of TiO_2. In our systematical schedule this new approach would be classified as the elimination of network modifiers as weakening elements in favor of network formers of weaker bond strength. (Third instead of Second Principle)

The use of TiO_2 as a flux in acid resistive vitreous materials was somewhat surprising to the practical ceramist who was taught to regard this oxide as refractory. The most extensive publication on the TiO_2 containing vitrifiable colors, the patents of Deyrup, brings out the great surprise even of the inventor.

In 1937 he discussed the effect of the use of excessive amounts of B_2O_3 in high silica glazes of relatively high chemical resistivity. When discussing the lithium colors we have seen that this compromise on melting temperature invariably involved a compromise on resistivity and gloss, too. The use of TiO_2 in these patents was also combined with the use of the three alkalis, thereby again utilizing the forementioned effect of lithium. An example of such a color is:

PbO	52.2
SiO_2	36.0
TiO_2	2.55
Li_2O	1.8
Na_2O	4.9
Al_2O_3	2.6

The resourcefulness of the men achieving the excellent vitrifiable colors of the present day may be recognized by the fact that still dissatisfied with the rather complex alkali-lead-borosilicate glasses containing Li_2O and TiO_2 they included other constituents in their batches such as cadmium oxide, thallium oxide, bismuth oxide, and fluorides, chlorides, bromides, and iodides, for instance, zinc fluoride and the lead halides. Table XIII shows an example developed by Deyrup.

	a	b
PbO	51.7	46.7
B_2O_3	8.1	—
SiO_2	18.5	39.7
TiO_2	4.6	3.4
Na_2O	1.3	2.8
K_2O	.5	—
Li_2O	—	2.9
CdO	3.4	—
$PbCl_2$	5.5	4.5
$PbBr_2$	4.1	—
PbI_2	2.3	—

Table XIII. Vitrifiable color containing Halides (Deyrup).

A vitrifiable color of this composition comprises all five structural changes with due consideration of the limitations of chemical resistivity and expansion.

Thallium is an element which would prove very useful in the field of low melting glazes, colors, and enamels. Thalium borate melts as low as 350°C; but unfortunately the high price and more so its poisonous character prohibit its systematic exploration. Skaupy, in a more thorough investigation of lead thallium borates, found that thallium decreased the yellow hue of the lead borate enamels and increased their resistivity; but enamels of this type were more inclined to devitrify and to turn grey on firing by reduction.

(10) Low Melting Phosphate Glasses

The utilization of the fact that P_2O_5 increases the oxygen ratio without contributing more algali ions to the glass has been described in the theoretical part. On the other hand, a combination of relatively high amounts of alkali and phosphoric acid provides glasses of an unusually low softening point, which gain our interest only if sufficient chemical resistivity is warranted. Through the addition of B_2O_3, ZnO, and Al_2O_3 Grimm and were able to stabilize phosphate glasses which contained 25 per cent alkali and had softening points around 400°C. Some glasses in this series are claimed to be as resistive to water as window glass. In European countries the present shortage of borax has stimulated its replacement by sodium phosphate. As far as there is information available on this subject, these enamels possess unchanged properties.

In the course of systematic studies of the application of phosphates to ceramic materials we have melted various combinations in related systems and gained the conviction that resistive glasses of low softening point can be suitably developed on a phosphate basis. As an example, the following diagram illustrates the softening point of such glasses in its dependency on the alkali type used. The lithium containing glasses are characterized by low softening points but an ever increasing tendency toward devitrification. Optimal conditions prevail near the ratio of 1 K : 2 Na; very small amounts of Li may be added to this glass. In this composition range the glasses also possess optimal resistivity. The pure potassium and sodium glasses were found less resistant.

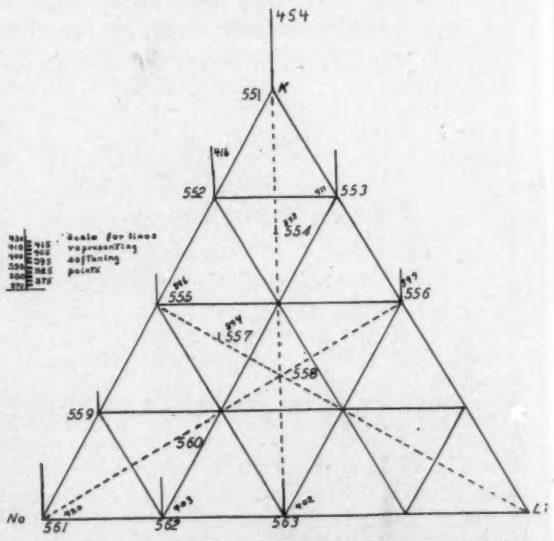


Fig. 9. Softening points of glasses of varying K-Na-Li contents. Base Glass: 40.5 P_2O_5 23 Al_2O_3 5 B_2O_3 4 ZnO 23.9 Na_2O (Na, K varied and partially replaced by Li).

. . . or peach, or blueberry . . . or any other kind of preserve that arrives in an Army camp today packed so attractively in glass containers that a soldier simply can't resist it?

Much of the high quality that is built into these modern containers—which carry some of the best food in the world to the best soldiers in the world—can be traced directly to the "built in" uniformity and high quality of Solvay Soda Ash.

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THE O. HOMMEL COMPANY
209 FOURTH AVE. PITTSBURGH, PENNA.
Phone ATlantic 1195

• C. H. Hahner has been appointed Chief of the Glass Section of the Bureau of Standards, succeeding Mr. A. N. Finn for whom he has served as acting chief for the past year. Mr. Hahner has been with the Glass Section since 1929. He holds a B. S. degree in Chemical Engineering from the State College of Washington and an M.A. in Chemistry from George Washington University.

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After framing the opening, only three simple wood members are required to erect the panel. As illustrated, a horizontal molding is first laid down. On top of this is placed the glass block and vertical separating strips. The wood strips interlock with the blocks by reason of their ridged faces which fit into the flutings on the edges of the blocks. Notched ends of the vertical moldings interlock with the horizontal moldings.

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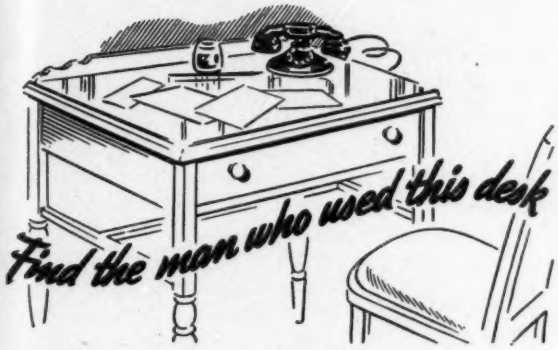

He's somewhere in Baltimore or Washington, keeping the business appointments he made by telephone from his room at the Lord Baltimore. He'll be back this evening because he'll be in this territory for several days; because he finds the Lord Baltimore convenient to Baltimore's war industries and official Washington and because the Lord Baltimore is the hotel that suits his rather discriminating taste.

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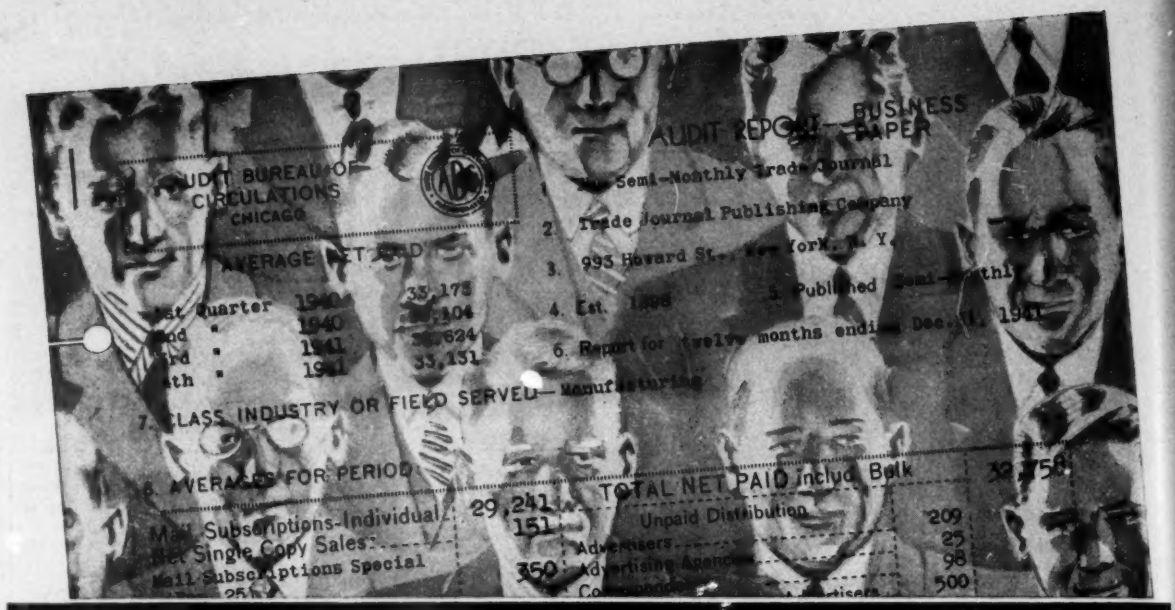

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THE GLASS INDUSTRY

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